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THE NORTHERN AND SOUTHERN KINDERHOOK FAUNAS

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The name "Kinderhook," as applied to a series of Paleozoic strata in the Mississippi Valley, was first used by Meek and Worthen¹ in 1861 for all those beds lying between the "Black Shale" below and the Burlington Limestone above. The name of this series of formations was taken from the village of Kinderhook, in Pike County, Illinois, where a good exposure of beds of this age occurs in the Mississippi River bluffs. Another typical section, designated by the authors of the name, included the beds exposed at Burlington, Iowa, lying below the Burlington Limestone and extending downward to beneath the river level. Besides these, the "Lithographic Limestone," "Vermicular Shales," and "Chouteau Limestone" in Missouri, as defined by Swallow and his assistants, were considered as the equivalents of the Kinderhook beds of Illinois and Iowa, as was also the so-called "Goniatite Limestone" of Rockford, Indiana.

The typical exposure of the Kinderhook Group, from which it has received its name, "is at the point of the bluff, just above the village of Kinderhook." The section at this place, as given by Worthen² and confirmed by the writer, is as follows:

5.	Loess capping the bluff	20	feet
4.	Burlington limestone	15	"
3.	Thin-bedded, fine-grained limestone	6	"
2.	Thin-bedded sandstone and sandy shales	36	"
1.	Argillaceous and sandy shales, partly hidden . . .	40	"

In connection with his description of the section at this locality, Worthen states that "the thin-bedded sandstones (bed No. 2) abound in fossil shells, belonging to the genera *Aviculopecten*, *Spirifer*, *Orthis*, and *Productus*, mostly identical with those from the grit

¹ *American Journal of Science*, Second Series, Vol. XXXII, p. 288.

² *Geological Survey of Illinois*, Vol. IV, p. 27.

stones at Burlington, which belong to the same horizon." Further than this, no description of the fauna of this typical Kinderhook section has ever been given.

The collection upon which the following list is based was made at the typical locality, the point of the bluff just above the village of Kinderhook. A few fossils were collected from the fine-grained limestone, bed No. 3, but they are so poorly preserved as to be scarcely identified with certainty. As indicated by Worthen in his original description of the section, the fossils occur most abundantly in the thin-bedded sandstones of bed No. 2. They do not, however, occur uniformly through this bed, but are restricted to a narrow horizon from 20 to 25 feet below the base of the fine-grained limestone, bed No. 3. The exact limits of this fossiliferous horizon have not been definitely determined because of the thickly covered talus slope, but it probably extends through not more than a foot or two of strata.

The fauna of this bed is of much interest, and the contained species will be briefly discussed in order.

1. **Orbiculoides** sp. undet. A single specimen of this species has been observed. It is a brachial valve about 15^{mm} in diameter; the apex is excentric and is more than ordinarily sharp for members of this genus, the surface of the shell sloping away on all sides from the apex to the margin, with a concave curve.
2. **Crania?** sp. undet. This species is represented in the collection by a single depressed-convex internal cast of a subcircular shell about 12^{mm} in diameter. It is too imperfect to allow its relationships to be determined with accuracy, and its generic identification may be incorrect.
3. **Orthothetes chemungensis** Con. The species of *Orthothetes* which occur in the Kinderhook beds of the Mississippi Valley are so indefinitely characterized that it is exceedingly difficult to make satisfactory identifications. Several different species have been described by various authors, and some of them at least are doubtless good species. The species from Kinderhook are apparently identical with those from the Chonopectus fauna at Burlington, Iowa, which have been identified as *O. inaequalis* (Hall),¹ but all the specimens are probably distinct from the

¹ Weller, *Transactions of the St. Louis Academy of Sciences*, Vol. X, p. 66, Plate 1, Fig. 18.

- typical form of *O. inaequalis*, and approach more closely to the *O. chemungensis* of the middle and upper Devonian faunas.
4. **Chonetes geniculatus** White. Several specimens of a small, finely marked *Chonetes*, although imperfectly preserved, seem to represent this species, which is typically a member of the Louisiana Limestone fauna.
 5. **Chonetes cf. C. ornatus** Shum. In the original description of *C. ornatus* the typical specimens were said to be from the Chouteau Limestone of central Missouri, and from what is now known as the Louisiana Limestone of northeastern Missouri. The figures of the species, published with the original description, do not adequately illustrate the specimens from either of these localities. Extensive collections of more recent date have shown that the Chouteau Limestone and Louisiana Limestone specimens belong to distinct species, although both are characterized by the peculiar concentric markings upon which the species, as originally described, was mainly established. The Chouteau Limestone specimens prove to be identical with the species from the Kinderhook Oolite of Burlington, Iowa, which was described by Norwood and Pratton as *C. logani*. The Louisiana Limestone shell attains a larger size at maturity, is marked with coarser and more angular plications, and is usually proportionately broader than *C. logani*; and the name *C. ornatus* may be restricted to this species. The specimens from Kinderhook are all internal casts and do not well preserve the specific characters, but they seem to agree more closely with the specimens of *C. ornatus* from the Louisiana Limestone than with any other species. The specimens somewhat resemble those from the Chonopectus fauna from Burlington, Iowa, identified as *Chonetes* sp. undet.,¹ and they may be identical.
 6. **Chonetes cf. C. illinoiensis** Wor. A third species of *Chonetes* occurs rarely in the Kinderhook fauna. It is larger than either of the others and is marked by finer radiating costæ, there being about 100 around the margin of a shell 15.5^{mm} broad. This shell has been identified provisionally with *C. illinoiensis*, as it has the general form and proportions of that species, and agrees more closely with it in all respects than with any other.

¹Weller, *loc. cit.* p. 69, Plate 1, Fig. 15.

7. **Productella** sp. undesc. This species is one of the more common members of the fauna, and is quite distinct from any heretofore described species of the genus from the Kinderhook faunas, from all of which it may be distinguished by its large size. It resembles some of the larger species from the Chemung beds of New York, but it is sufficiently distinct from any of them. Most of the specimens observed are more or less weathered, and in this condition some of the smaller individuals resemble weathered specimens of *Chonopectus fischeri*, the proportions of the two shells being much the same, but no authentic specimens of *Chonopectus* have been observed from this locality. The species has been named *P. sublaevis*, and a description with illustrations will be published elsewhere.
8. **Productus curtirostris** Win. This species, described from the Chonopectus fauna at Burlington, was, in a former paper,¹ referred to the brachial valve of *P. semireticulatus*. Additional specimens, however, studied since that paper was published, have demonstrated that the species was well founded, it being a remarkably depressed form of *Productus* of the *semireticulatus* type. The specimens from Kinderhook seem to be indistinguishable from those occurring at Burlington.
9. **Productus semireticulatus** Mart.? A species of *Productus* of the *semireticulatus* type, identical with the one so identified from the Chonopectus fauna at Burlington,² occurs in the fauna at Kinderhook. The only specimen representing the species is an external impression of the brachial valve which is scarcely different from similar specimens of *P. burlingtonensis* Hall, except that it is flatter. The pedicle valve also, as seen in specimens from Burlington, is not so strongly convex or ventricose as *P. burlingtonensis* from the Burlington Limestone.
10. **Productus** sp. undet. This species is represented by fragmentary specimens only, but, so far as can be determined, it is identical with the shells in the Chonopectus fauna at Burlington, formerly identified as *P. cooperensis* Swall.³ This identifica-

¹ Weller, *loc. cit.*, p. 70, Plate 1, Figs. 7, 8.

² Weller, *loc. cit.*, p. 70, Plate 1, Figs. 5, 6.

³ Weller, *loc. cit.*, p. 71, Plate 1, Figs. 3, 4.

tion, however, is incorrect, the original *P. cooperensis* being a much smaller shell from the Chouteau Limestone of central Missouri, and entirely distinct from this one.

11. **Paraphorhynchus transversum** Weller. This shell is identical with a species in the Chonopectus fauna at Burlington, which has been identified as *Pugnax striatocostata* M. & W. var.?¹ but the species is sufficiently distinct from the typical form of *striatocostata*, it being proportionately much broader than that species and attaining a larger size at maturity.²
12. **Spirifer subrotundatus** Hall. The specimens of this species from the beds at Kinderhook are indistinguishable from those in the Chonopectus fauna at Burlington.
13. **Spirifer marionensis** Shum. This is one of the more common species of the fauna, and is of especial interest because it is identical with the shell so common in the fauna of the Louisiana Limestone of Missouri, which may be assumed to be the typical form of the species. The shells from the Chouteau Limestone and other Kinderhook formations of Missouri, excepting the Louisiana Limestone, as well as those from the Kinderhook beds Nos. 5-7 at Burlington, which have usually been identified as *S. marionensis*, are distinct from the typical Louisiana Limestone representatives of the species. This typical form may be recognized by its less prominent umbo, and by the more nearly obsolete fold and sinus, and although the Louisiana Limestone and Chouteau Limestone species are much alike, they are doubtless specifically distinct.
14. **Syringothyrsus extenuatus** Hall. Most of the specimens of this species from Kinderhook are separate brachial valves which are more or less imperfect. A single specimen, however, preserves both valves in such a manner that the angle between the plane of the brachial valve and the cardinal area of the pedicle valve can be approximately measured. This angle is 38°, a little larger than the average angle of the specimens in the Chonopectus fauna at Burlington, which vary but little from 30°. It is, however, much closer to these Burlington specimens than to

¹ Weller, *loc. cit.*, p. 72, Plate 2, Figs. 16, 17.

² Weller, *Transactions of the St. Louis Academy of Sciences*, Vol. XV, p. 264.

the specimens of *S. hannibalensis* Swall., from the Louisiana Limestone, in which this angle does not vary much from 60°. In its flat cardinal area also the Kinderhook specimens agree with *S. extenuatus* rather than with *S. hannibalensis*, in which the area is usually more or less concave.

15. **Aviculopecten** sp. undet. A single imperfect specimen of a species of this genus has been observed. It is certainly distinct from any of the species in the Chonopectus fauna at Burlington, and may be an undescribed form.
16. **Pterinopecten** cf. **P. laetus** Hall. Several imperfect specimens of this shell have been observed, which are undoubtedly identical with those so identified from the Chonopectus fauna at Burlington,¹ although it is quite possible that they represent an undescribed species distinct from, but allied to, *P. laetus* Hall.
17. **Pernopecten cooperensis** Shum. This species has as yet not been recognized in the Chonopectus fauna at Burlington, but the Kinderhook specimens which have been observed are indistinguishable from specimens occurring in bed No. 5 in the Burlington section.
18. **Leiopteria undulata** M. & W. The type specimen of this species, described originally as *Pterinea? undulata*,² is said to have come from the Kinderhook at Burlington, Iowa. The authors of the species state, however, that they "have also seen some imperfect casts, very similar to this species, and possibly not distinct from it, from the same horizon, at Kinderhook, Ill. The latter are left valves, and seem to be a little more convex than in the typical examples." The specimens from Kinderhook mentioned by Meek and Worthen were undoubtedly the same as the specimens here under consideration. The species has not been seen by the writer from Burlington, but it doubtless occurs in the Chonopectus fauna at that locality. The figured type specimen is a very imperfect shell, showing parts of both valves; but, so far as it is preserved, it does not seem to differ in any marked degree from the specimens from Kinderhook.

¹ Weller, *Transactions of the St. Louis Academy of Sciences*, Vol. X, p. 83, Plate 3, Figs. 1, 2.

² *Geological Survey of Illinois*, Vol. III, p. 456, Plate 14, Fig. 5.

19. **Avicula strigosa** White. The specimens of this species from Kinderhook are all imperfectly preserved, but they seem to show no essential differences from the typical members of the species in the Chonopectus fauna at Burlington.
20. **Pteronites whitei** Win. A single very perfect left valve of this species occurs in the collection, and is indistinguishable from the members of the species in the Chonopectus fauna at Burlington.
21. **Goniophora jennae** Win. This is another Chonopectus fauna species, but it seems to be more common at Kinderhook than at Burlington. The specimens exhibit some variation, but in general they correspond quite closely with the smaller of the two type specimens figured by Weller.¹
22. *Undetermined pelecypod.* This species is represented by two specimens of a small *Allorisma*- or *Grammysia*-like shell, too imperfect for identification.
23. **Sphaerodoma pinguis** Win. A single specimen in the collection is apparently identical with this species which was originally described from the Chonopectus fauna at Burlington.
24. **Straparollus** sp. undet. A small specimen too imperfect for identification.
25. **Bellerophon** sp. undet.
26. **Patellostium scriptiferus** White. The specimens of this species from Kinderhook are identical, in all their essential characters, with the typical representatives of the species from the Chonopectus fauna at Burlington.
27. **Brachymetopus** sp. undet.

The most noticeable feature of this fauna is its striking similarity to the Chonopectus fauna at Burlington, although the total number of species recognized is much smaller, and the most characteristic species at Burlington, *Chonopectus fischeri*, has not been noticed at Kinderhook. In spite of the absence of this species, however, the fauna can be definitely stated to be equivalent to the fauna of the yellow sandstone at the summit of bed No. 2 at Burlington, and doubtless this yellow sandstone at Kinderhook and the yellow sandstone at Burlington would be found to be a continuous forma-

¹ Loc. cit., Plate 3, Fig. 14.

tion, if the outcrop could be traced through the intervening area. This correlation is of especial interest, because it assists in tying together the Kinderhook faunas at Burlington with those of north-eastern Missouri, which are separated by the synclinal folding of the strata which carries the beds far beneath the surface in the area between.

The presence in the fauna of numerous specimens of *Spirifer marionensis*, of the typical form occurring so abundantly in the Louisiana Limestone, is another factor of great importance. This species is entirely absent from the Chonopectus fauna at Burlington, nor is it represented by any species at all closely allied to it. In the Burlington section no species of *Spirifer* likely to be confused with *S. marionensis* occurs except in the higher beds, Nos. 5 and 6, and this species, although it has usually been identified with *S. marionensis*, is believed to be a distinct form, which in Missouri occurs only in the Chouteau Limestone or its equivalents, and in beds lying above the Louisiana Limestone. Other species which are common to the Louisiana Limestone fauna and the one under consideration are *Chonetes geniculatus* and probably *Chonetes ornatus*, and of these one, *C. geniculatus*, and perhaps also the other, are recognized in the Chonopectus fauna at Burlington.

Although the relationships between this fauna from Kinderhook and the Louisiana Limestone fauna are far less striking than between the fauna at Kinderhook and the Chonopectus fauna at Burlington, yet it is believed that they are all but different facies of one fauna, the Louisiana Limestone expression being characteristically the limestone facies, while the Chonopectus fauna at Burlington represents the arenaceous facies. Another point bearing upon the correlation is the presence in the Louisiana Limestone of one of the commonest and most characteristic pelecypod species of the Chonopectus fauna, viz., *Grammysia plena* Hall.¹

In the sections at both Kinderhook and Burlington there is a bed of fine-grained, more or less fragmental limestone, resembling in a marked degree the Louisiana Limestone of Missouri at Hannibal and Louisiana. On the Mississippi River the Louisiana Limestone

¹ A specimen of this species has been seen by the writer in the collection of Professor R. R. Rowley, of Louisiana, Missouri.

attains a maximum thickness of 60 feet, but at Kinderhook the limestone layer above the yellow sandstone is but 6 feet in thickness, while at Burlington it has a maximum thickness of 18 feet. At Kinderhook this limestone is but sparsely fossiliferous, although one of the species recognized, *Productella pyxidata*, is one of the commonest members of the Louisiana Limestone fauna. At Burlington, Iowa, the fauna of the limestone (beds Nos. 3 and 4) above the yellow sandstone of bed No. 2 contains a modified facies of the Chonopectus fauna. *Chonopectus fischeri* is a common species, and associated with it is *Paraphorhynchus striatocostatum*, which sometimes occurs abundantly. This species was originally described from Kinderhook, and, judging from the lithologic characters of specimens from Pike County, Illinois, in the collection of Walker Museum, it occurs in the fine-grained limestone above the yellow sandstone. The same species, in its typical form, has been collected by Professor Rowley in the Louisiana Limestone.¹ Another species binding the fauna of the fine-grained limestone at Burlington to that of the Louisiana Limestone is *Syringothyris halli* Win., which is apparently but a small form of *S. hannibalensis* so characteristic of the Louisiana Limestone. Both of these species are distinct from, but closely allied to, the species of the same genus occurring in the yellow sandstone beds at both Burlington and Kinderhook, and known as *S. extenuatus* Hall.

The interrelationships of the various expressions of the Louisiana-Kinderhook-Burlington faunas under discussion are such as to make their correlation a matter of some certainty. It may be assumed that we have to deal here with one general contemporaneous formation, exhibiting at Louisiana and elsewhere on the Mississippi River a limestone facies throughout, while east and north, at Kinderhook and Burlington, the sediments were largely arenaceous, the conditions for the deposition of calcareous sediments not being introduced until near the close of the time epoch represented.

Another factor which adds to the strength of the correlation of

¹ The writer has not seen a specimen from the Louisiana Limestone, but Professor Rowley states that he has collected a very perfect specimen, which is no longer in his collection. Hall and Clarke also illustrate a specimen of this species (*Paleontology of New York*, Vol. VIII, Part II, Plate 60, Figs. 33, 34.) from Pike County, Missouri, which doubtless came from the Louisiana Limestone.

the Louisiana Limestone with beds No. 2-4 at Burlington is afforded by the identity of the faunas of the superjacent beds in both regions. The fauna of beds Nos. 5 and 6 are modifications of one and the same organic assemblage, which exhibits characteristics totally different from those of the faunas below. This fauna of the upper beds of the Kinderhook section at Burlington is characterised by such genera of pelecypods as *Macrodon*, *Palaeoneilo*, *Promacrus*, and *Crenipecten*, and by the brachiopods *Chonetes logani*, *Lepaena rhomboidalis*, and *Spirifer* sp. allied to *S. marionensis*, but distinct from it. The whole expression of the fauna is entirely different from that of the beds below. In the vicinity of Louisiana this same fauna of the upper beds at Burlington is well exhibited in the yellow, vermicular, arenaceous beds near the summit of the Hannibal Shales, which overlie the Louisiana Limestone.

At Kinderhook the conditions are somewhat different, no evidence of the presence of the higher fauna having yet been found. At this locality the fine-grained limestone bed is apparently followed immediately by the typical Burlington Limestone, bearing the typical fauna of that horizon.

In tracing the further distribution of the fauna of the yellow sandstone of Kinderhook and Burlington, it is found to occur 60 miles northwest of Burlington, in Washington County, Iowa, at Maples' Mill on English River, near Wellman. At this locality a yellow sandstone similar to that at Burlington has been called the "English River Grit" by Bain.¹ The fauna of this bed is rather extensive, and contains the following species:

1. **Scalarituba missouriensis** Weller. Some portions of this Sandstone are perforated by meandering burrows with transverse concave ridges which are in every way similar to those in the Hannibal and Northview Sandstones of Missouri.
2. **Orthothetes** sp. The specimens of this genus from the English River Grit are larger and more numerous than those of the Chonopectus Sandstone at Burlington. They may perhaps be identified as *O. chemungensis* Hall; at least they are closely allied to that New York Devonian species.

¹ *American Geologist*, Vol. XV, p. 322; *Iowa Geological Survey*, Vol. V, p. 134.

3. **Schizophoria** cf. **S. swallowi** Hall. This species is represented in the collection by a single specimen. It is specifically identical with the species in the Chonopectus Sandstone at Burlington, which has been referred to *S. swallowi*. The condition of preservation of neither the Burlington nor the English River specimens is sufficiently good to make such an identification absolutely certain, but they seem to agree more closely with that Burlington Limestone species than with any other.
4. **Chonopectus fischeri** (N. & P.). This species, which is so characteristic of the fauna at Burlington, is present in the English River Grits, but is much less common.
5. **Productus laevicostus** White. This *Productus* is one of the less common species of the fauna, but it differs in no essential respect from specimens occurring elsewhere.
6. **Productus curtirostris** Win.
7. **Productus** 2 or 3 undet. species.
8. **Productella concentrica** Hall. Several specimens of this species are present in the collection from English River, which are indistinguishable from examples occurring in the faunas of beds Nos. 5 and 6 at Burlington, but the species has not been observed at the latter locality in the Chonopectus Sandstone.
9. **Productella nummularis** (Win.). This is one of the common species in the English River fauna, while at Burlington it is rare. Individuals from the two localities agree closely in all essential respects.
10. **Paraphorhynchus transversum** Weller. This is a rare species in the English River fauna, but the specimens differ in no essential characters from those occurring at Burlington and Kinderhook.
11. **Rhynchonella?** sp. A single specimen too imperfectly preserved for recognition.
12. **Eumetria altirostris** White. In the English River fauna this species grows to a larger size and is much more abundant than in the Chonopectus Sandstone at Burlington.
13. **Athyris corpulenta** (Win.). This species is much more common in the English River fauna than at Burlington, but none of the specimens observed are perfectly enough preserved to admit of

- the correct generic reference of the species. It undoubtedly is not an *Athyris*, but it may be allowed to remain in that genus until more definite knowledge of its characters can be gained.
- 14. **Spirifer** sp. undesc. This is a peculiar, elongate, narrow species, whose shell is plicated throughout. It has been named *S. maplensis*, and a description with illustrations will be published elsewhere.
 - 15. **Spirifer bispinosus** Hall. This species is not uncommon in the fauna, the individuals not differing essentially from Burlington specimens. The species is remarkable because of its exceedingly elongate hinge-line, produced in long mucronate extensions.
 - 16. **Syringothyris extenuatus** Hall. A single brachial valve, of rather large size, is the only representative of this species in the collection. It agrees perfectly with similar specimens from the Chonopectus Sandstone at Burlington.
 - 17. **Aviculopecten?** sp. undet. A single imperfect specimen of a very large Aviculopecten-like shell is preserved in the English River collection. When complete, its breadth must have been 100^{mm} or more, but its state of preservation is such as will not admit of definition.
 - 18. **Pernopecten cooperensis** Shum. Several more or less imperfect specimens are present in the collection, which may be certainly identified with this species. The species has not been certainly recognized in the Chonopectus fauna at Burlington, but it occurs rarely at Kinderhook. It is especially characteristic of the Kinderhook faunas of central Missouri and of the higher Kinderhook faunas at Burlington.
 - 19. **Leiopteria spinalata** (Win.). A single imperfect specimen of this species has been observed from English River. Its characters are not well shown, but it appears to be identical with the Burlington shells.
 - 20. **Leiopteria** sp. undesc.
 - 21. **Pteronites whitei** (Win.). A single small specimen from English River seems to belong to this species. Its extreme length is only 15^{mm}, but it agrees in all essential characters with the larger shells from Burlington and Kinderhook, and may be safely considered as an immature individual.

22. **Mytilarca occidentalis** W. & W. The specimens of this species in the English River fauna are similar to those of the Chonopectus fauna at Burlington.
23. **Goniophora jennae** (Win.). The English River specimens of this species are identical with the larger one illustrated from the Chonopectus fauna at Burlington. The smaller specimens from that locality should probably be separated from *G. jennae* as a distinct species, to which the Kinderhook, Illinois, shells should be referred.
24. **Macrodon cochlearis** Win. This is one of the common species of the fauna, and the specimens do not differ essentially from the Burlington examples.
25. **Grammysia plena** Hall. A single imperfect left valve of this species has been observed, but its identification with the Burlington specimens is entirely satisfactory.
26. **Sphenotus iowensis** (Win.). Specimens of this species from English River are similar to those from Burlington in all essential characters.
27. **Sphenotus** sp. undet.
28. **Murchisonia** sp. undet.
29. **Naticopsis depressa** Win. The "fine regular elongate nodes," mentioned in the original description of this species as marking the upper ends of the striæ of growth, could not be detected upon either of the two specimens marked as types in the University of Michigan collection, and no others from Burlington have been studied by the writer. Two specimens from English River, however, show this characteristic nicely, which leads to the supposition that all of the type specimens used by Winchell in the description of the species are not preserved in the collection at Ann Arbor.
30. **Straparollus** sp. undet. This is a rather common species in the fauna, but it is usually not well preserved. It resembles *S. angularis*, but does not have the angular revolving ridge of that species.
31. **Bellerophon bilabiatus** W. & W. This species, which is one of the commonest ones in the Chonopectus fauna at Burlington, is likewise a common species in the English River Grit.

32. **Bellerophon vinculatus** W. & W. This species is much more common at English River than at Burlington.
33. **Bellerophon** sp. undet. Two undetermined species of this genus are recognized in this fauna, one or both of which are probably undescribed.
34. **Euphemus** sp. undet. Two species of this genus occur in the English River fauna, both of which are probably undescribed. The genus has not been observed in the Chonopectus fauna at Burlington, and heretofore it has been described from the Kinderhook only in the faunas of central and southwestern Missouri.
35. **Porcellia obliquinoda** White. A single fragment of a shell of this species has been observed from English River, but, so far as it is preserved, it is essentially similar to specimens from the Chonopectus fauna at Burlington.
36. **Dentalium grandaevum** Win. This species, which is present in the Chonopectus fauna at Burlington, and also in the fauna of the upper yellow sandstone (bed No. 5) at the same locality, is represented by numerous fragments in the English River fauna.
37. **Orthoceras whitei** Win. A single imperfect fragment of this species has been observed, but it is sufficiently well preserved to make its identification certain.
38. **Orthoceras heterocinctum** Win. This species is somewhat more common than the last, but it is always preserved in a fragmentary condition.
39. **Phragmoceras expansum** Win.? A fragmentary specimen is identified with a query as this species, but too little of the specimen is preserved to make the identification certain.
40. Fish remains? Eastman¹ has called attention to some small, peculiar, bilobed bodies from Burlington, where they occur in the Chonopectus Sandstone, which are probably ichthic in nature, but their systematic position cannot even be guessed. Similar specimens occur in the English River Grit, although they seem to be specifically distinct from the Burlington specimens. Occurring as they do in this fauna at distant localities, it becomes a matter

¹ *Journal of Geology*, Vol. VIII, pp. 36, 40.

of convenience to be able to refer to them by name, and therefore I propose for them the generic name *Idiodus*. The Burlington species may be called *I. eastmani*, and the English River species *I. biloba*.

This fauna of the English River Grit is essentially that of the Chonopectus bed at Burlington, but with certain modifications. *Chonopectus fischeri*, although present in the fauna, is not one of the most abundant species; in fact, although most of the species at Maples' Mill can be identified with Burlington forms, many of those that are common at Burlington are rare on English River, and, *vice versa*, rare species at Burlington are in several instances more common on English River.

In Marshall and Tama Counties, Iowa, in the region of Le Grand, 120 miles northwest of Burlington, the entire Kinderhook section is not exposed. Several beds of limestone have been quarried extensively, and have afforded an abundance of fossils, the best-known of which are the famous Le Grand crinoids. The faunas of all these limestone beds are closely allied to that of the higher beds at both Burlington and Louisiana. Beneath these limestones, of which the lowest is a white oolite, there is a 20-foot bed of blue argillaceous sandstone¹ rarely exposed, which at Indiantown, about two miles east of Le Grand, is said to be very friable and of a yellowish tone due to weathering.² At this latter locality casts of fossils are said to occur, and although none of them have come under the observation of the writer, yet it seems quite possible that they may represent the Chonopectus fauna, and they should be carefully examined with that point in view.

The known distribution of the arenaceous facies of the Kinderhook fauna under discussion extends along a line having a general northwest-southeast direction, from Kinderhook, Illinois, to Burlington, Iowa, and thence to near Wellman, Iowa—a total distance of nearly 140 miles. If the fauna of the bluish or yellowish sandstone near Le Grand should prove to be the same, 60 miles more would be added to its northward distribution.

The outcrop of the limestone facies of the formation, with its

¹ Beyer, *Iowa Geological Survey*, Vol. VII, p. 222.

² *Ibid.*, p. 223.

characteristic fauna, extends from near Hannibal, Missouri, nearly 60 miles to Hamburg, Illinois, where there are about four feet of strata referable to this formation, carrying the typical fauna as seen at Louisiana. The entire distribution, therefore, of both the arenaceous and calcareous facies of this Kinderhook fauna extends along a comparatively straight line for 200 or 250 miles.

The distribution of the beds carrying the fauna, which at Burlington and Louisiana is confined to the higher beds of the Kinderhook section, is quite different from the distribution of the beds just discussed. This fauna has its most characteristic expression in the Chouteau Limestone of central Missouri, especially in Pettis and Cooper Counties. At Pin Hook Bridge over Muddy Creek, 10 miles northeast of Sedalia in Pettis County, there are 60 feet or more of Chouteau Limestone, usually of a bluish-gray color, sometimes yellowish, and sometimes arenaceous or cherty. This limestone rests with apparent conformity upon limestones which are of Devonian age, as indicated by the fossils. Lying above the Chouteau Limestone is the Burlington Limestone, whose lower beds in this county contain a fauna identical with the lower beds of the same formation at Burlington, Iowa. At Sweney, 15 miles north of Sedalia on the Missouri, Kansas & Texas Railroad, a large quarry has been opened in the Chouteau Limestone, exposing about 60 feet, with probably the same Devonian limestone beneath it, and the Lower Burlington Limestone above it, as at the Pin Hook section. At neither of these sections have the details of the distribution of faunules been studied out, but the fauna as a whole bears the same expression as the fauna of the uppermost beds at Burlington and Louisiana, although at Burlington the beds bearing this fauna do not exceed 11 feet in thickness, more than half of which is a yellow sandstone,¹ and at Louisiana the fauna, so far as observed, is restricted to Keyes bed No. 8, 12 feet of brown sandy shale.² Furthermore, at no locality in central or southern Missouri has any trace of the Chonopectus fauna of the Burlington section been observed, nor of the fauna of the Louisiana Limestone.

In southwestern Missouri the same Chouteau fauna occurs that

¹ Bed No. 7, the soft, buff, gritty limestone at Burlington, is not here included, as its fauna is much more closely related to that of the overlying Burlington Limestone.

² *Missouri Geological Survey*, Vol. IV, p. 47.

is present in central Missouri, but the beds containing it do not constitute one continuous limestone formation. Instead, three distinct formations are recognizable in Green County. The lowest of these is a limestone identical in lithologic characters with the lower beds of the Chouteau Limestone of Pettis County, and carries essentially the same fauna.¹ Its thickness may be estimated at about 10 feet, and it may be considered as the thinned edge of the Chouteau Limestone lens.² The second member occupying the Kinderhook interval in Green County has been called the Northview,³ and corresponds with Shepard's Hannibal Shale, except that the limestone at the base is excluded as noted above. In its lithologic characters this formation is essentially identical with the Hannibal Shale and Sandstone lying above the Louisiana Limestone in northeastern Missouri, and the faunas of the two formations are related. However, the Northview and the Hannibal do not constitute one continuous formation, the entire interval in central Missouri being occupied by the Chouteau Limestone. The highest Kinderhook bed in Green County is the Pierson Limestone.⁴

In northern Arkansas all the Kinderhook beds, so far as they have been examined, are characterized by the faunas related to that of the Chouteau Limestone. In southeastern Missouri, Kinderhook beds are well exposed in the Mississippi River bluff near Sulphur Springs and Kimmswick, and elsewhere in Jefferson and St. Louis Counties. The most characteristic fauna in this region occurs in a red calcareous shale. The fauna is peculiar in some respects, but its affinities are with the Chouteau faunas of central and southwestern Missouri, and not at all with the Louisiana-Chonopectus fauna; this fauna is recognized as far north as southern Jersey County, Illinois.

¹ In an earlier paper ("Correlation of the Kinderhook Formations of Southwestern Missouri," *Journal of Geology*, Vol. IX, pp. 130-48) this lowest bed of the Kinderhook section in Green County was taken to be identical with Shepard's Sac Limestone. This was an error, as further investigation has shown. The Sac Limestone lies beneath this Kinderhook limestone, the Phelps Sandstone with its *Ptyctodus* fauna being between. This lowest limestone of the Kinderhook interval was given but little mention by Shepard in his *Green County Report*, being included in his Hannibal Shales. On p. 87, he speaks of these lower harder beds being used for curbing, etc., and on p. 202 he mentions these beds as the Hannibal limestone.

² For the fauna of this bed see *Journal of Geology*, Vol. IX, pp. 136, 137.

³ Weller, *Journal of Geology*, Vol. IX, p. 140.

⁴ Weller, *loc. cit.*, p. 144.

At a distance from the Ozark region, the Chouteau fauna is recognized in the Goniatite Limestone of Rockford, Indiana, where the Cephalopod genus *Prodromites* occurs, the further distribution of this genus being in the Chouteau Limestone of Pettis County, Missouri, and in the higher beds at Burlington. In certain portions of the Waverly of Ohio, Kentucky, and Indiana characteristic elements of the same fauna may be recognized. In still another direction this fauna occurs in the limestones of the higher portion of the Kinderhook beds in Marshall County, Iowa, and in the Wassonville limestone of Washington County, Iowa.

From a detailed consideration, therefore, it is seen that the Kinderhook strata of the Mississippi Valley region contain two distinct faunal assemblages, each of which shows modifications into various facies. During earlier Kinderhook time these two faunas were restricted, one to the more northern, the other to the more southern region, and the two Kinderhook provinces were separated by some barrier, doubtless a land barrier. Near the close of the Kinderhook epoch, the barrier separating the two provinces was removed, and the fauna from the south migrated into the northern province. The northern fauna, however, probably continued to live in a more and more restricted area to the close of Kinderhook time, since at Kinderhook, Illinois, there is apparently no evidence of the presence of the southern fauna in any beds between those bearing the typical northern Kinderhook fauna and the base of the Burlington limestone. With the removal of the barrier, however, the northern fauna did not make any headway into the southern province.